Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

UNITED STATES DEPARTMENT OF AGRICULTURE

In Cooperation with
Clemson Agricultural College, South Carolina

DEPARTMENT BULLETIN No. 1488

Washington, D. C. ▼ April, 1927

MANUFACTURING TESTS OF COTTON OF THE WHITE GRADES OF THE UNIVERSAL STANDARDS FOR AMERICAN COTTON

By HORACE H. WILLIS, *Cotton Technologist, Division of Cotton Marketing, Bureau of Agricultural Economics* [1]

CONTENTS

	Page
Purpose of test	1
Mechanical conditions	2
Moisture conditions	2
Percentages of waste	4
Waste and cotton per 500-pound bale	6
Strength of yarns	7
Method of presentation of strength data	7
22s gray warp yarn (skein)	8
22s warp yarn, bleached and dyed (skein)	12
22s warp yarn (single strand)	13
28s two-ply yarn (single strand)	14
Irregularity of yarns	15
22s warp yarn (skein)	15
28s two-ply yarn (single strand)	20
Variation of the sizings	21
Difference in value between grades	22
Strength of cloth	24
Manufacturing properties	25
Finishing properties	26
Summary	28

PURPOSE OF TEST

The spinning tests here described were conducted to determine the relative intrinsic value of each of the nine white grades of American upland cotton as represented by the universal standards for American cotton. [2]

These standards, which became effective August 1, 1924, superseded the former official cotton standards of the United States, tests of which are given in Department Bulletin 591, "Manufacturing Tests of the Official Cotton Standards for Grade." The results shown in this bulletin are based on the new standards for white grades. A thorough study of the manufacturing properties has been made, including waste, working qualities, strength, and bleaching and dyeing qualities of the yarn and of the cloth made from each of the nine grades.

An effort has been made to correlate such factors as the price of the raw cotton, value of waste, and value of yarn to make the results of value to cotton growers, cotton factors, and manufacturers.

[1] The writer acknowledges the cooperation of the several managers of finishing plants, manufacturers, and cotton factors in these tests. The spinning tests were conducted under the general supervision of Arthur W. Palmer, in charge of Division of Cotton Marketing, and under the direct supervision of Horace H. Willis, cotton technologist, assisted by H. B. Richardson and C. E. Folk, assistant marketing economists; E. S. Cummings, assistant in cotton testing; and Miss Etta Zeh, assistant scientific aid.

[2] For a detailed description of the cotton standards, see Department Circular 278, "The Commercial Classification of American Cotton," by Arthur W. Palmer, and Service and Regulatory Announcements No. 92 (Agricultural Economics), "Standards for Cotton Classification in the United States and Abroad," by Chester L. Finch.

33065°—27——1

The following nine grades of upland cotton seven-eighth to 1 inch in length of staple grown east of the Mississippi River and similar lots grown west of the Mississippi were tested:

Middling Fair	No. 1
Strict Good Middling	No. 2
Good Middling	No. 3
Strict Middling	No. 4
Middling	No. 5
Strict Low Middling	No. 6
Low Middling	No. 7
Strict Good Ordinary	No. 8
Good Ordinary	No. 9

The test lot of each of these grades of cotton consisted of a composite sample of approximately 250 pounds taken in equal portions from three different bales of that particular grade. The cotton for the spinning test was selected from bales which were being used in making up the types of working standards for grade. In order to reduce other variables, cotton was selected which was deemed to be as nearly as possible uniform in staple and character. The grade was certified by a committee authorized to class cotton under the provisions of the United States cotton futures act and of the United States cotton standards act. The grade of the cotton will be designated by number throughout this report.

MECHANICAL CONDITIONS

To determine the comparative waste, these lots of cotton representing each of the nine white grades were run under similar mechanical conditions, the drafts, speeds, and settings conforming to usual mill practice. The net weight of cotton taken from the bale was recorded, then the cotton was passed through the opener, and placed in a bin and allowed to condition for 24 hours, during which time it either gained or lost in weight, depending upon its character, the moisture in it, and the weather conditions. This gain or loss was reflected in the invisible waste from the pickers.

After 24 hours the cotton was taken from the bin, weighed, and passed through the breaker and finisher pickers. The production and waste at these machines were weighed and recorded. As soon as convenient the production (called laps) from the pickers was transferred to the card room, weighed, and passed through the cards. The production and waste were again weighed. The cotton was then passed through two processes of drawing frames, three processes of roving frames, and then to the spinning department. Frequent weighings of the laps, slivers, and roving were made to ascertain whether proper size or weight was being delivered.

MOISTURE CONDITIONS

The relative humidity in the different rooms was kept as nearly constant as possible. It has been found from experiments that a relative humidity of 50 per cent in the picker room, 60 per cent in the card room, and 70 per cent in the spinning and weaving rooms gives satisfactory results. It is not always possible to maintain precisely these moisture conditions, as the relative humidity is affected by the weather. Table 1 gives the averages of the hourly readings of the prevailing temperatures and relative humidities and the time required to pass each grade through each machine. Only in extreme weather

conditions did the relative humidity fluctuate more than 2.5 per cent under or over the average as given in Table 1. Since the relative humidity was observed and regulated every 15 minutes, the average readings per hour were considered sufficient.

TABLE 1.—*Average of hourly readings of room temperatures, average relative humidity during processing, and time required by each type of machine for each grade of cotton* [1]

Machine	Temperature and relative humidity	Eastern upland									Western upland									Time run per machine and grade
		Grade									Grade									
		1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9	
																				Hours
Opener	Degrees F	86	86	71	81	77	69	87	82	89	87	88	73	82	78	71	79	88	80	3
	Per cent	62	57	56	58	68	54	57	57	58	61	54	51	56	70	55	62	61	57	
Pickers	Degrees F	86	86	76	73	75	67	86	80	91	89	87	78	76	77	69	78	90	72	4
	Per cent	63	57	60	54	60	52	58	62	55	61	54	59	54	59	49	67	59	53	
Cards	Degrees F	84	82	74	74	74	65	84	74	86	83	83	77	72	72	65	75	85	74	12
	Per cent	62	58	61	61	59	58	62	60	61	63	61	61	59	60	58	63	62	59	
Drawing	Degrees F	84	83	76	73	73	65	85	66	87	81	83	81	73	74	66	76	86	80	8
	Per cent	62	61	62	59	60	57	62	54	61	62	60	61	59	61	60	59	61	61	
Slubber	Degrees F	82	83	77	73	75	67	86	68	85	81	84	83	69	76	66	76	87	78	3
	Per cent	60	60	60	59	59	60	61	59	60	61	61	63	60	60	61	61	64	62	
Intermediate	Degrees F	82	84	82	70	74	67	86	69	84	31	81	84	75	77	67	76	87	74	5
	Per cent	61	61	61	58	61	60	63	59	60	62	62	58	61	62	62	63	60	60	
Fine	Degrees F	81	84	84	76	78	68	85	67	85	84	82	84	83	80	74	77	84	67	5
	Per cent	62	61	59	60	61	63	62	60	61	64	60	56	61	63	61	61	60	59	
Spinning	Degrees F	84	85	81	80	79	75	86	74	83	84	85	81	80	79	75	79	83	75	5
	Per cent	69	71	71	71	70	71	72	69	71	69	71	71	71	70	71	71	71	69	

[1] Temperatures expressed in degrees Fahrenheit and relative humidity in percentages.

Samples were collected for moisture tests at regular intervals during the manufacturing processes. These samples do not necessarily represent the average conditions of the entire lot of cotton of the particular grade from which the samples were taken, but they do show the amounts of moisture in the sample at the time taken. The results of these tests are shown in Table 2.

Cotton, being highly hygroscopic, may either gain or lose in weight, depending upon the amount of moisture in the cotton, the outside weather conditions, and the temperature and relative humidity of the room in which the test is conducted. The gains and losses are indicated in Table 3.

TABLE 2.—*Percentage of moisture regain in samples of the several grades at successive stages in processing* [1]

Sample	Eastern upland									Western upland									Average moisture regain, all grades
	Grade									Grade									
	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9	
	P.c.	*P.c.*	*P.c.*	*P.c.*	*P.c.*	*P.c.*	*P.c.*	*P.c.*	*P.c.*	*P.c.*	*P.c.*	*P.c.*	*P.c.*	*P.c.*	*P.c.*	*P.c.*	*P.c.*	*P.c.*	*P.c.*
Raw stock	6.49	7.18	5.81	6.55	7.64	6.60	7.01	6.84	7.01	6.55	6.60	5.93	6.89	7.18	5.26	6.38	6.32	7.58	6.66
Breaker picker lap	6.15	6.49	6.38	5.37	6.72	6.10	5.48	6.43	5.59	6.60	5.76	6.04	5.42	6.60	5.15	6.72	5.70	5.48	6.01
Finisher picker lap	6.21	6.32	5.70	4.77	6.55	5.70	5.76	6.26	5.20	6.10	5.15	5.54	5.21	6.26	5.37	6.72	5.98	5.15	5.78
Lap back of card	6.43	5.76	6.15	5.32	6.75	5.84	5.82	6.32	5.59	5.88	5.51	6.21	5.65	6.26	5.65	6.43	5.98	5.48	5.95
Card sliver	6.43	5.90	6.04	5.64	6.84	6.18	5.46	6.38	5.98	5.98	5.90	5.81	5.70	6.60	6.04	6.49	5.90	5.70	6.05
Breaker drawing sliver	6.32	6.26	6.55	5.48	6.89	5.99	5.65	6.21	6.04	6.72	6.26	6.32	5.48	6.66	5.70	6.10	6.10	6.26	6.17
Finisher drawing sliver	6.49	6.43	6.84	5.76	6.49	6.38	5.59	5.76	5.54	6.66	6.32	6.26	5.71	6.55	6.21	6.32	6.38	5.93	6.20
Roving, fine frame	6.55	6.32	5.98	6.60	6.78	6.32	6.26	5.98	5.59	6.43	6.26	6.10	5.93	6.55	6.49	6.66	6.21	6.10	6.28
Roving, creel of spinning	7.99	7.64	7.41	7.35	7.01	8.11	7.01	7.46	6.32	7.35	7.87	7.24	6.95	6.72	7.35	7.52	6.49	7.12	7.27
Yarn	9.17	8.16	8.57	7.87	7.81	8.99	7.35	8.75	6.95	8.69	8.45	8.22	7.35	7.24	8.57	8.22	7.35	8.51	8.12

[1] The amount of moisture that may be taken up by bone-dry cotton is called regain. The percentage of regain is determined by multiplying the amount of moisture taken up by 100 and dividing the result by the dry weight.

TABLE 3.—*Percentage of the different kinds of waste removed by the pickers and cards from each of the nine grades*

Machine and kind of waste	Eastern upland								
	Grade								
	1	2	3	4	5	6	7	8	9
PICKERS [1]	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Opener breaker motes and fly	0.75	0.80	0.80	1.03	1.18	1.62	2.73	2.45	3.88
Finisher motes and fly	.64	.78	.70	.81	1.07	1.08	1.41	1.81	2.48
Total visible waste	1.39	1.58	1.50	1.84	2.25	2.70	4.14	4.26	6.36
Invisible waste	.03	.90	.09	1.63	.77	.82	1.50	.98	1.70
CARDS [2]									
Flat strips	1.53	1.64	1.76	1.55	2.10	2.04	2.20	2.39	2.58
Cylinder and doffer strips	.66	.71	.72	.54	.90	.68	.96	.70	.80
Motes and fly	1.79	1.87	1.87	2.03	2.22	2.45	3.27	4.23	5.11
Sweepings	.10	.07	.19	.23	.24	.35	.25	.13	.26
Total visible waste	4.08	4.29	4.54	4.35	5.46	5.52	6.68	7.45	8.75
Invisible waste or gain	[3].17	[3].68	[3].92	[3].56	[3].20	[3].46	[3].20	0.00	.22
PICKERS AND CARDS [1]									
Total visible waste	5.41	5.76	5.97	6.04	7.55	8.03	10.44	11.32	14.40
Total invisible waste or gain	[3].14	.24	[3].82	1.09	.58	.38	1.31	.98	1.90

Machine and kind of waste	Western upland								
	Grade								
	1	2	3	4	5	6	7	8	9
PICKERS [1]	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Opener breaker motes and fly	0.73	0.69	0.76	1.07	1.50	1.69	2.17	3.12	3.30
Finisher motes and fly	.63	.60	.69	.91	1.00	1.29	1.62	2.16	2.64
Total visible waste	1.36	1.29	1.45	1.98	2.50	2.98	3.79	5.28	5.94
Invisible waste	.29	1.13	.55	1.46	1.63	1.12	.80	1.33	2.93
CARDS [2]									
Flat strips	1.55	1.56	1.71	1.76	2.01	2.08	2.26	2.41	3.03
Cylinder and doffer strips	.64	.64	.74	.64	.86	.68	.94	.81	1.12
Motes and fly	2.00	1.56	2.04	2.08	2.12	2.45	3.37	4.26	4.86
Sweepings	.10	.27	.23	.18	.15	.16	.22	.15	.35
Total visible waste	4.29	4.03	4.72	4.66	5.14	5.37	6.79	7.63	9.36
Invisible waste or gain	[3].17	[3].43	[3].56	[3].56	[3].24	[3].14	[3].29	.34	[3].08
PICKERS AND CARDS [1]									
Total visible waste	5.58	5.22	6.07	6.48	7.43	8.13	10.27	12.41	14.47
Total invisible waste	.12	.71	0.00	.92	1.40	.99	.52	1.65	2.86

[1] Percentages based on net weight fed to opener.
[2] Percentages based on net weight fed to cards.
[3] Invisible gain.

PERCENTAGES OF WASTE

Percentages of waste were determined from the net weight of cotton fed to, delivered by, and discarded by each cleaning machine. There are two kinds of waste in cleaning: (1) Visible, that which may be gathered and weighed and put to some other use; (2) in-

visible, that which results in a change in weight caused by loss or gain in moisture, or by small particles passing off in the air. The amount of this invisible waste is affected by the character of the cotton in process, by outside weather conditions, and by the temperature and relative humidity of the room in which the test is conducted.

The percentage of waste on each machine is based on the net weight fed to that machine. The net weight fed to the cards is less than the weight fed to the pickers by the amount of waste removed by the pickers. The percentage of total waste removed is not obtained, therefore, by adding the waste percentages for pickers and cards. For example, follow the computations for grade No. 3 (eastern cotton) in Table 3. For every 100 pounds of raw cotton fed to the pickers, 1.50 pounds (1.5 per cent) of visible waste were removed and 98.41 pounds of cotton delivered, leaving 0.09 pound (0.09 per cent) not accounted for and designated as invisible loss. The total waste on the pickers is therefore 1.59 per cent.

The 98.41 pounds delivered from the pickers were fed to the cards which removed 4.47 pounds (4.54 per cent) of waste and delivered 94.85 pounds of cotton, making a total of 99.32 pounds. This latter figure exceeds the weight fed by 0.91 pound (0.92 per cent of the quantity fed to the cards). This 0.92 per cent is called invisible gain.

Combining the pounds of visible waste (1.50+4.47), dividing it by 100 (pounds fed to the opener), and multiplying this result by 100 gives the percentage of total visible waste removed. Total visible waste removed by the pickers and cards is 5.97 per cent, an amount slightly smaller than the sum of the visible wastes (6.04 per cent) recorded in Table 3 as from pickers and cards.

The total invisible waste is figured in a manner similar to that used for determining the total visible waste. Note that there was a loss of 0.09 pound on the pickers and a gain of 0.91 pound on the cards. Therefore, 0.91 pound gain on cards minus 0.09 pound loss on pickers equals a net gain of 0.82 pound, which, based on 100 pounds fed to opener, is 0.82 per cent again. The greater portion of this gain on the card is due to the fact that approximately 60 per cent relative humidity is maintained in the card room, whereas approximately 50 per cent relative humidity is maintained in the picker room where the preceding process takes place.

The percentage of total visible waste from each grade of the eastern and western cottons is given in Table 4.

TABLE 4.—*Percentage of total visible waste from pickers and cards, by grades of eastern and western cottons*

Type of cotton	Grade								
	1	2	3	4	5	6	7	8	9
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Eastern	5.41	5.76	5.97	6.04	7.55	8.03	10.44	11.32	14.40
Western	5.58	5.22	6.07	6.48	7.43	8.13	10.27	12.41	14.47
Average	5.50	5.49	6.02	6.26	7.49	8.08	10.36	11.86	14.44

The average of the total visible waste from each grade of the eastern and western cotton is shown graphically in Figure 1. Data used in this graph were taken from Table 4. The cross on each vertical grade line indicates the total amount of visible waste removed from that grade. These crosses have been connected by the dotted line for convenience in reading. The solid curve best represents the waste data. The method of locating this curve is to draw it among

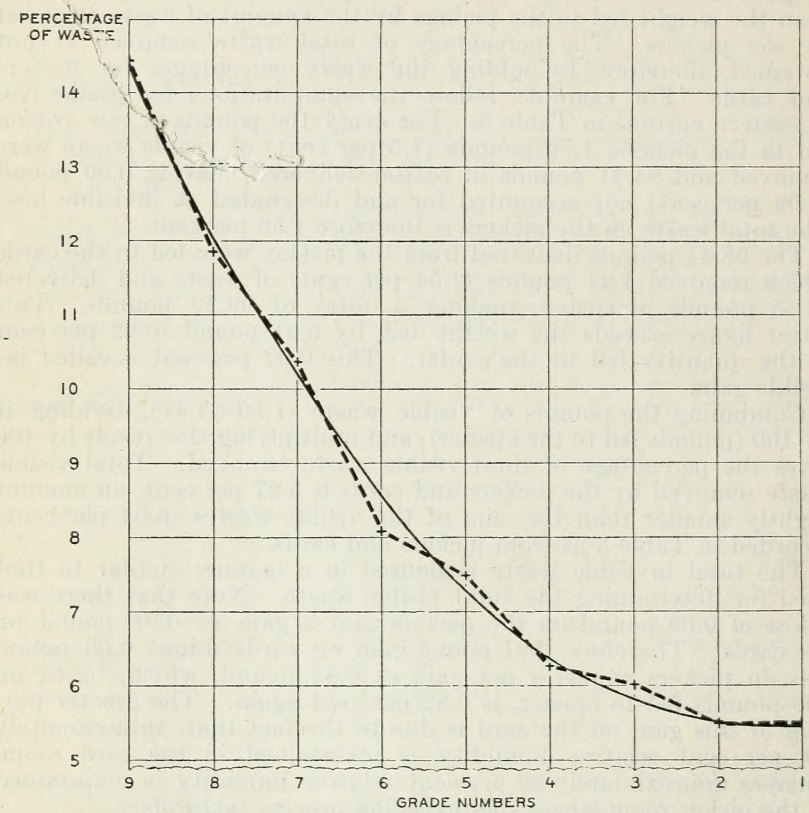

FIG. 1.—Average percentage of total visible waste from eastern and western cotton of each of the nine grades. The crosses on the dash line indicate the actual waste removed in the test while the solid-line curve is the best representative line

the points representing the waste percentages so that the sum of the squares of the distances of the points above the curve is equal to the sum of the squares of the distances below the curve.

WASTE AND COTTON PER 500-POUND BALE

The pounds of waste and of cotton per bale as found in this test are given in Table 5.

The waste may be divided into two parts—spinnable and nonspinnable. To the first class belong the flat strips which are the highest quality of waste removed from cotton used in manufacturing carded yarns. These are usually spun into coarse yarns. To the second class

belong the motes and fly from the pickers and the cards. This waste is run through special machines which separate the trash from the short fibers. These fibers are used for various purposes, such as wadding and packing. In the case of low-grade cotton, however, even the flat strips may be found nonspinnable, in which event they are put to uses similar to those of motes and fly.

TABLE 5.—*Tare,*[1] *visible waste, and cotton removed from each 500-pound bale of the several grades*

Bale contents	Grade								
	1	2	3	4	5	6	7	8	9
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Waste	26. 18	26. 13	28. 66	29. 80	35. 65	38. 46	49. 31	56. 45	68. 73
Cotton	449. 82	449. 87	447. 34	446. 20	440. 35	437. 54	426. 69	419. 55	407. 27

[1] Tare assumed to be 24 pounds in each case. Invisible waste disregarded.

STRENGTH OF YARNS

The cotton of each grade was manufactured into 22s warp yarn, 28s filling yarn, and 28s two-ply soft twist yarn, the latter for the purpose of mercerization. The twist inserted in the 22s yarn was 19.9, 21.1, and 22.3 turns per inch. Twenty-four skeins were reeled and tested from each twist of each grade, giving a total of 72 determinations for each grade. Thirty-two determinations were made by the single-strand method on the middle twist of each grade. These yarns were conditioned and tested on standard-speed motor-driven machines under an automatically controlled relative humidity of 65 per cent at a temperature of 70° F.

METHOD OF PRESENTATION OF STRENGTH DATA

Space forbids the inclusion in numerical form of complete data relating to each of the various strength tests, but in the case of 22s gray warp yarn spun from No. 5 eastern and western cottons, respectively, such complete data are given. (See sample Tables 6 and 7.) These tables are included in order to show the thoroughness of the tests. Data for all other strength tests were obtained in a similar manner, are on file, and copies will be furnished on request. This publication does include, however, graphic presentations of the results of each strength test made, each graph being based on observations similar to those recorded in Tables 6 and 7.

In plotting the data a series of parallel vertical grade lines, numbered consecutively from 9 to 1 corresponding to the grades of the universal standards for American cotton, are drawn equal distances apart. The observed strength in pounds or ounces, as the case may be, is noted on the particular vertical grade line. These points have been connected for convenience in following the results of any one of the several comparative tests.

22s GRAY WARP YARN (SKEIN)

One of the chief requisites of warp yarn is strength. This property is highly desirable because the yarn during weaving must withstand high tension as well as chafing. Strength is also important in respect to the wearing qualities of the cloth.

Examples of the strength data for 22s gray warp yarn spun from grade No. 5 eastern and western cottons are given in Tables 6 and 7, respectively. The break per 22s is found by multiplying the average strength by the average size and dividing by the specified number—22 in this case. As an illustration, refer to columns under 19.9 turns, Table 6. The 89.67 pounds (average strength) multiplied by 21.20 (average size) divided by 22 (specified number) equals 86.41 (break per 22s). Similarly, other strengths per 22s were determined.

TABLE 6.—*Variation in skein break and size of 22s gray yarn spun from No. 5 eastern cotton*

Observations	Turns per inch for 22s gray yarn					
	19.9		21.1		22.3	
	Break or strength	Size	Break or strength	Size	Break or strength	Size
	Pounds	*Count*	*Pounds*	*Count*	*Pounds*	*Count*
1	90.5	21.25	88.0	20.75	89.0	21.25
2	92.5	21.25	92.0	20.75	90.0	21.25
3	87.0	21.75	88.0	21.25	90.5	20.75
4	83.0	22.00	90.0	21.00	90.5	20.75
5	91.0	20.75	96.0	[1] 19.75	92.0	20.25
6	91.5	20.75	89.5	21.25	[1] 83.0	21.25
7	90.0	20.75	94.5	20.25	87.0	20.75
8	90.5	21.25	94.0	20.25	86.5	[1] 22.25
9	94.0	20.75	91.0	20.25	94.0	20.50
10	92.5	21.50	81.5	22.00	89.5	20.50
11	87.0	21.50	94.5	20.50	[1] 96.5	20.50
12	85.5	21.75	[1] 98.5	20.50	87.5	20.50
13	93.0	20.25	92.0	21.00	92.5	20.25
14	90.5	20.75	94.0	21.00	94.5	20.25
15	93.0	21.25	[1] 80.5	[1] 22.25	95.0	20.50
16	88.0	[1] 20.25	86.0	21.25	94.0	[1] 20.00
17	89.0	21.50	91.5	21.00	95.0	20.50
18	89.5	21.25	92.0	20.25	95.0	21.00
19	[1] 97.0	20.50	90.5	20.75	90.0	22.00
20	86.0	[1] 22.25	81.0	21.25	86.0	20.50
21	[1] 82.0	21.75	93.5	19.75	92.0	20.25
22	85.0	21.50	85.5	21.00	96.5	20.25
23	92.0	20.75	93.0	20.75	92.0	20.75
24	92.0	21.50	94.0	20.50	91.5	20.50
Total	2,152.0	508.75	2,171.0	499.25	2,190.0	497.25
Average	89.67	21.20	90.46	20.80	91.25	20.72
Break per 22s	86.41		85.53		85.94	
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Average deviation [2]	3.22	2.07	4.06	2.17	3.13	1.94
Extreme variation [2]	16.73	9.43	19.89	12.02	14.79	10.86

[1] Extremes.

[2] See discussion of irregularity of yarns (p. 15) for method of calculation.

TABLE 7.—*Variation in skein break and size of 22s gray yarn spun from No. 5 western cotton*

Observations	Turns per inch for 22s gray yarn					
	19.9		21.1		22.3	
	Break or strength	Size	Break or strength	Size	Break or strength	Size
	Pounds	*Count*	*Pounds*	*Count*	*Pounds*	*Count*
1	83.5	22.25	90.5	21.50	87.5	21.25
2	89.0	21.00	87.5	21.50	90.0	21.25
3	91.0	21.25	98.0	21.00	98.5	20.50
4	89.5	21.00	90.0	20.50	98.0	21.75
5	90.5	20.75	82.0	22.25	91.0	21.00
6	89.5	21.75	89.5	21.25	93.0	20.00
7	90.0	21.50	87.0	21.25	[1] 106.5	20.00
8	91.0	21.25	92.0	21.00	91.0	20.75
9	82.5	[1] 22.25	93.0	21.00	86.0	[1] 22.00
10	90.0	21.50	92.5	21.00	102.0	20.25
11	83.0	22.00	[1] 100.0	20.75	94.0	20.50
12	93.5	21.25	88.0	21.25	92.0	21.00
13	93.0	21.75	95.5	[1] 20.25	92.0	20.75
14	83.5	21.50	90.5	20.75	86.0	22.00
15	88.0	21.25	[1] 79.5	21.75	97.5	20.25
16	92.0	21.50	81.5	21.25	92.0	20.75
17	94.5	20.75	87.0	[1] 22.50	98.5	[1] 20.00
18	[1] 105.0	[1] 20.25	99.0	20.75	92.0	21.50
19	90.5	20.75	86.5	22.00	[1] 82.5	21.75
20	92.0	20.75	85.0	22.25	89.0	21.25
21	[1] 81.5	22.00	90.0	21.00	89.0	20.75
22	94.5	21.25	92.5	21.50	93.0	21.50
23	89.0	21.50	93.0	21.00	90.5	21.00
24	84.0	21.50	98.0	20.75	91.5	20.75
Total	2,150.5	512.50	2,168.0	510.00	2,223.0	502.50
Average	89.60	21.35	90.33	21.25	92.63	20.94
Break per 22s	86.95		87.25		88.17	
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Average deviation [2]	3.97	1.85	4.66	2.06	4.26	2.39
Extreme variation [2]	26.23	9.37	22.69	10.59	25.91	9.55

[1] Extremes.
[2] See discussion of irregularity of yarns (p. 15) for method of calculation.

The average strength of yarns of each twist of each grade is given in Table 8, which was compiled for each grade from data similar to those shown in Tables 6 and 7.

TABLE 8.—*Strength of yarn in pounds per skein of 120 yards (22s yarn spun from eastern and western upland cotton)*

Kind of cotton	Turns per inch	Grade of cotton								
		1	2	3	4	5	6	7	8	9
		Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Eastern	19.9	85.2	86.8	87.9	82.9	86.4	78.4	83.4	74.6	78.8
	21.1	85.3	88.0	88.4	84.4	85.5	78.6	82.8	73.6	79.6
	22.3	84.1	87.4	88.0	81.0	86.0	77.5	84.9	73.1	78.5
Average		84.9	87.4	88.1	82.8	86.0	78.2	83.7	73.8	79.0
Western	19.9	102.6	96.0	82.8	92.2	87.0	90.4	86.3	80.2	80.5
	21.1	103.7	97.2	83.4	90.4	87.3	89.5	86.3	80.9	82.2
	22.3	102.0	96.1	83.3	90.2	88.2	87.3	85.1	79.4	81.1
Average		102.8	96.4	83.2	90.9	87.5	89.1	85.9	80.2	81.3

Figure 2 is a graphic presentation of the strength of 22s warp yarn spun from each grade of eastern upland cotton. The dash line indicates the actual conditions, the point of intersection of the dash line with the vertical grade line being the average strength of the yarn produced from that particular grade. Strength does not follow the grade in all cases, but there is a tendency in that direction. Note that only grades No. 2 and No. 3 equaled or exceeded the new Draper standard, the well-known commercial standard developed as the result of much research at Hopedale, Mass. The solid line is the best representative straight line through the data and indicates that there is a tendency for the cotton to produce stronger yarn as the grade becomes better.

Figure 3 is a graphic presentation of the strength of the yarn spun from the different grades of western upland cotton. Note that Nos. 1, 2, 4, 5, and 6 exceeded the new Draper standard strength for 22s

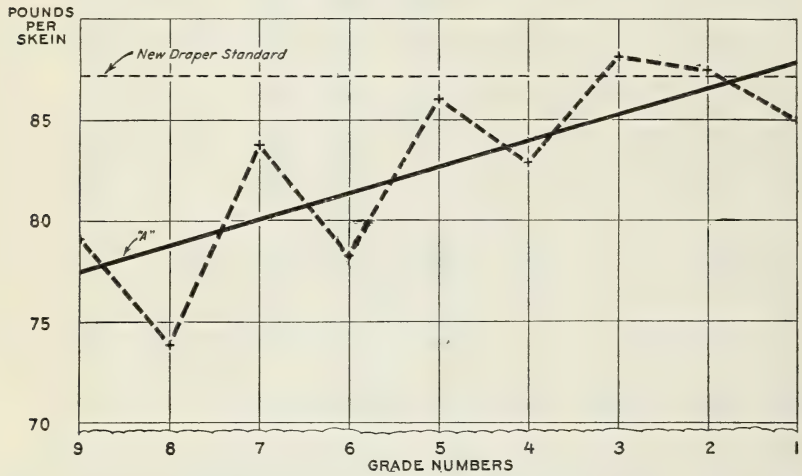

FIG. 2.—Strength in pounds per skein of 22s gray warp yarn spun from eastern upland cotton. The crosses on the dash line indicate the average strength obtained from 72 observations, while the solid line "A" is the best representative line. Note the tendency for the strength to increase as the grades vary from No. 9 to No. 1. (See Table 8.)

warp yarn. On an average, the western upland yarn was found to be 7.2 per cent stronger than the eastern, which may be due in part to adverse weather conditions which prevailed in the Southeast during the harvesting season of 1924.

Length and character of staple may or may not be affected by conditions which influence grade. Grade is largely dependent upon climatic conditions, care exercised in picking or harvesting, and methods of ginning, whereas length and character are varietal characteristics. For instance, two bales of cotton may be of the same grade, but the yarn spun from one may be much weaker than that spun from the other, even though the manufacturing methods and conditions remain unchanged. Thus, the strength variation from the trend line (figs. 2, 3, and 4) may be attributed to these conditions.

Figure 4 is a graphic presentation of the average strength obtained by combining the results of the 72 determinations of each grade of eastern and western lots (figs. 2 and 3). Note that in this case only

the average of grades 1 and 2 exceeded the strength of the new Draper standard for 22s carded warp yarn.

Figure 4 shows that there is less variation in average strength of the several grades from the best representative line than is shown in

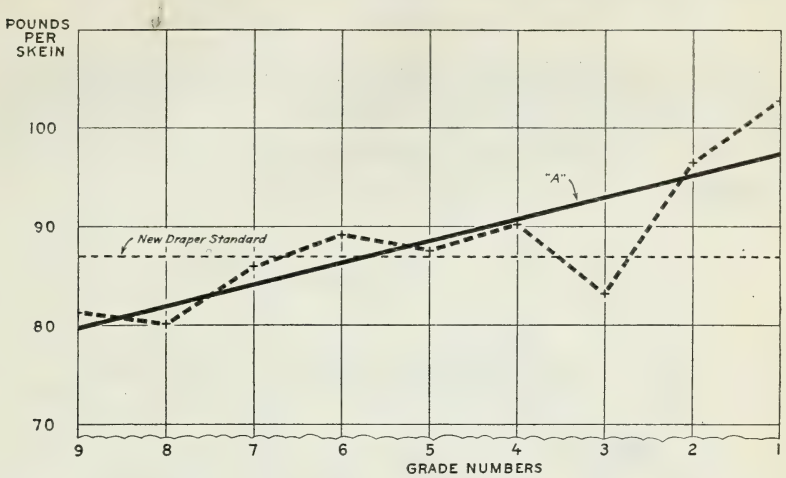

FIG. 3.—Strength in pounds per skein of 22s gray warp yarn spun from western upland cotton. The crosses on the dash line indicate the average strength obtained from 72 observations, while the solid line "A" is the best representative line. Note the tendency for the strength to increase as the grades vary from No. 9 to No. 1. (See Table 8.)

either Figure 2 or Figure 3. This greater uniformity or decreased variation from the trend line is due mainly to the fact that a greater number of bales was used. The result for each grade was obtained

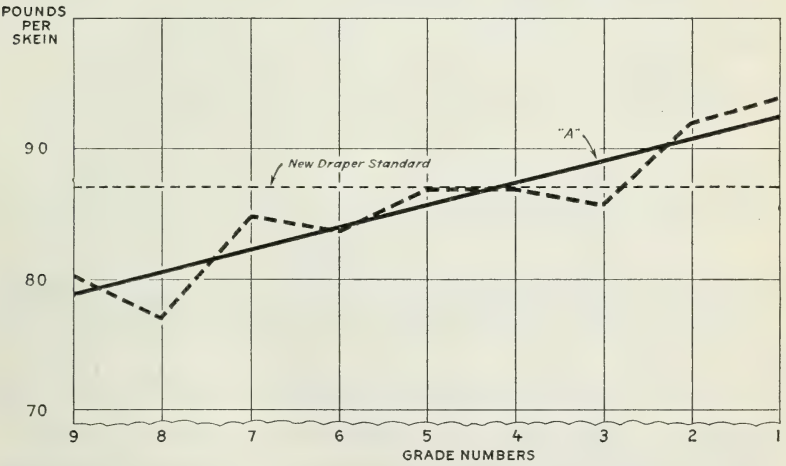

FIG. 4.—Average strength in pounds per skein of 22s gray warp yarn spun from eastern and western upland cotton (average of results shown in Figs. 2 and 3). The variation of the plotted data from the best representative line "A" is less than in either Figure 2 or Figure 3. The strength has a tendency to increase from grade 9 to grade 1

from 144 observations, 72 eastern and 72 western. This is permissible since the same number of bales was used in the case of the eastern as in the western cotton. In commercial mills this greater uniformity is

obtained by mixing from 15 to 30 bales of cotton in the opening room. If the bales were taken one by one and were not mixed, the manufactured product would probably show streaks of high and low quality rather than an average uniformity.

22s WARP YARN, BLEACHED AND DYED (SKEIN)

A portion of the 22s gray yarn of each grade was bleached and a portion bleached and dyed in a commercial mill. The effects of these processes upon the strength and brightness of the yarn were studied. All grades were treated at the same time, that the same conditions

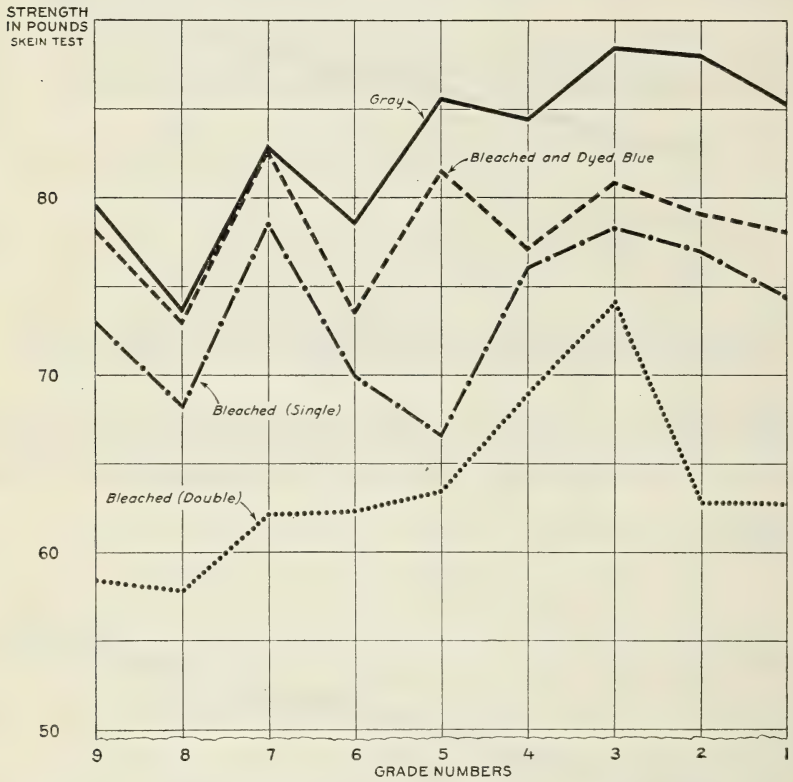

FIG. 5.—Skein strength of 22s gray and treated yarns spun from eastern cotton. (21.1 turns per inch in yarn.) The gray yarn is stronger than the treated yarn of the same grade. The extent to which the double bleaching has decreased the strength of the yarn from that of the single bleach is shown

might prevail in all cases. One lot was given a single bleach, a second lot was given a double bleach, and a third lot was dyed on the single-bleach base. The results of the strength tests on these lots are shown graphically in Figures 5 and 6.

Single bleach reduced the strength of the eastern yarns approximately 11 per cent. The double bleach reduced the strength of the eastern yarns 23 per cent. The double-bleached yarn was 13 per cent weaker than the single-bleached, indicating that double bleaching has a marked detrimental effect on the strength of the yarn. The dyed blue yarns were 6 per cent weaker than the gray yarns. The above percentages are based on averages of the nine grades (fig. 5).

The single-bleached western yarns were approximately 10 per cent weaker than the gray, whereas the double-bleached yarns were 22 per cent weaker than the gray. The double-bleached yarns were 13 per cent weaker than the single-bleached. The dyed blue western yarns were 5 per cent weaker than the gray. These percentages are based on the averages of grades 1 to 9 (fig. 6).

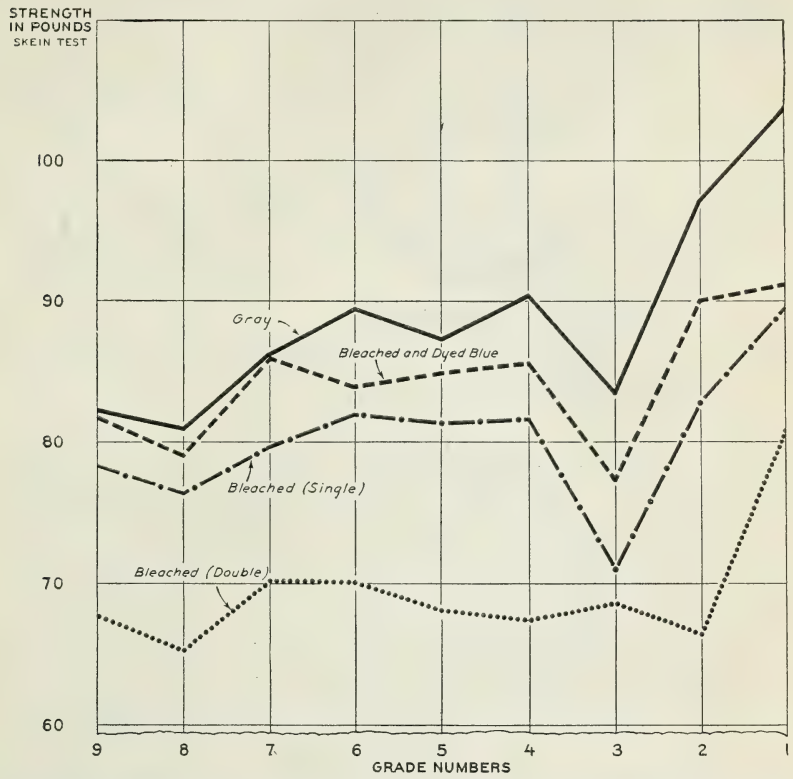

FIG. 6.—Skein strength of 22s gray and treated yarns spun from western cotton. (21.1 turns per inch in yarn.) The gray yarn is stronger than the treated yarn. The decrease in strength of grade 3 is probably due to the influence of weather or cultural conditions upon the strength and character of the cotton. The extent to which double bleaching has decreased the strength of the yarn from that of the single bleach is shown

A comparison of the results in Figures 5 and 6 and of the two preceding paragraphs shows that the eastern and western cottons were similarly affected when bleached and dyed by the same method.

22s WARP YARN (SINGLE STRAND)

The single-strand method is advocated by some manufacturers in preference to the skein method on the supposition that it gives a truer index of the quality of the yarn. Correction has been made for differences in the size of the yarn by multiplying the average machine break of the single strand by the average size found in the skein break of the corresponding yarn and dividing this result by 22. Figures 7 and 8 show graphically the results of the single-strand tests.

There is a marked similarity between the results of the single-strand tests and of the skein tests, although the results do not check in every instance. It is possible that such differences may be due to the fact that single-strand tests do not cover so large a quantity of yarn as do the skein tests.

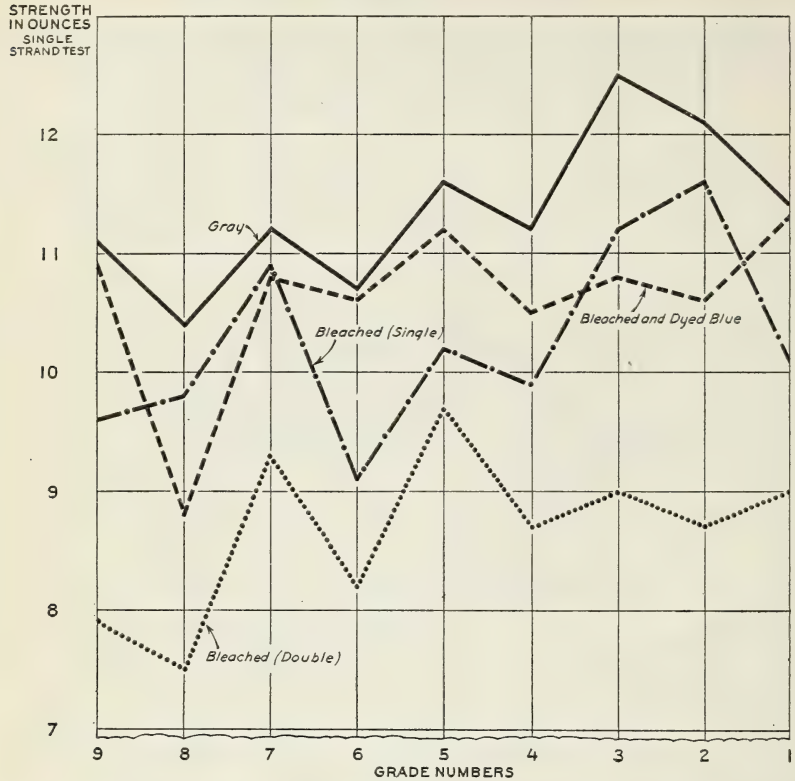

FIG. 7.—Strength in ounces per single strand of 22s gray and treated warp yarns spun from the eastern upland cotton. (21.1 turns per inch in yarn.) The gray yarn is stronger than the treated yarns. The double bleach has decreased the strength of the yarn from that of the single bleach

28s TWO-PLY YARN (SINGLE STRAND)

The 28s two-ply yarn, mercerizing twist, spun from each grade of cotton was bleached; bleached and mercerized; and bleached, mercerized, and dyed. These yarns were broken by the single-strand method, the results of which were corrected on the basis of the size of gray yarn. The average strength of yarns finished by two plants is shown graphically in Figures 9 and 10.

The results of single-strand tests of the two-ply yarn show a tendency for the yarns spun from the higher grades to have a greater breaking strength than those spun from the lower grades.

IRREGULARITY OF YARNS

The specifications for the purchase of yarns are usually based upon the average strength and size. The average strength alone, however, is not always a true index of the quality of the yarn. Two yarns may have the same average strength but differ in uniformity. There are several methods of determining the irregularity of yarns, two of which are used herein: (1) Plotting the range of strength

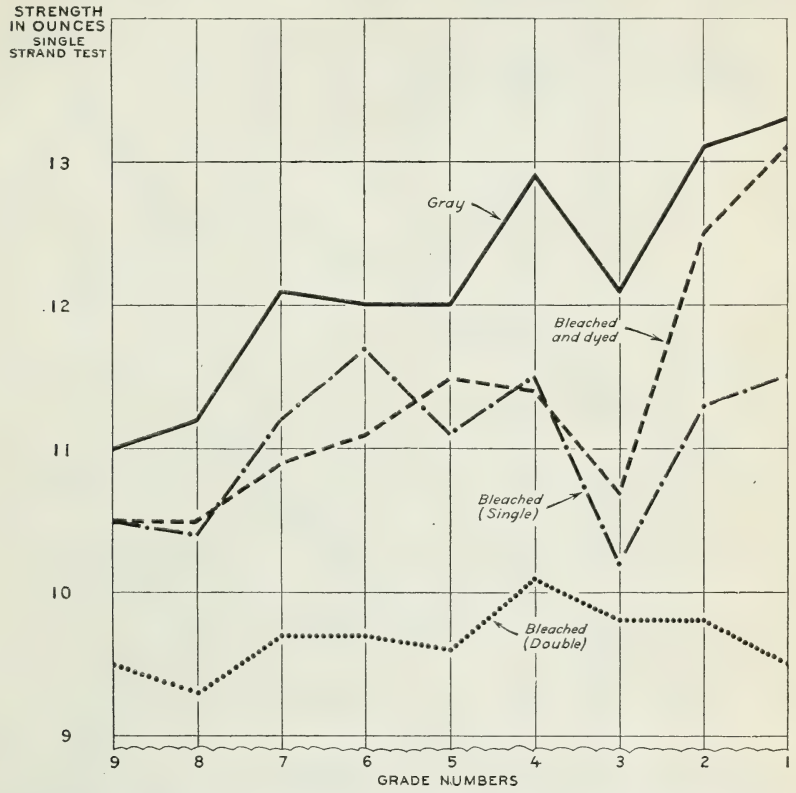

FIG. 8.—Strength in ounces per single strand of 22s gray and treated warp yarns spun from the western upland cotton. (21.1 turns per inch in yarn.) The gray yarn is stronger than the treated yarns. The double bleach has decreased the strength of the yarn from that of the single bleach

from the corrected breaks, and (2) calculating the percentages of average deviation and extreme variation of the breaks.

22s WARP YARN (SKEIN)

Figures 11 and 12 show graphically the irregularity of the skein break of the 22s single yarn spun from the eastern and western cottons respectively (method 1). This irregularity is indicated by the angle the curve makes with the horizontal—the greater the angle of the curve, the more irregular the yarn, the smaller the angle, the more uniform the yarn. The percentage of extreme variation of the corrected breaks, represented by any one of the curves on Figure 11 or

Figure 12, may be obtained by dividing the difference between the maximum and minimum strength by the average strength, and multiplying this result by 100. As an illustration, take curve No. 8 in Figure 11: 79 pounds (maximum strength on curve) minus 68.5 pounds (minimum strength on curve) equals 10.5 pounds (difference). Dividing 10.5 by 73.7 (the strength found on the 50 per cent vertical line) and multiplying this result by 100 gives 14.25 (per cent extreme variation for this particular grade). This method is applicable to any grade.

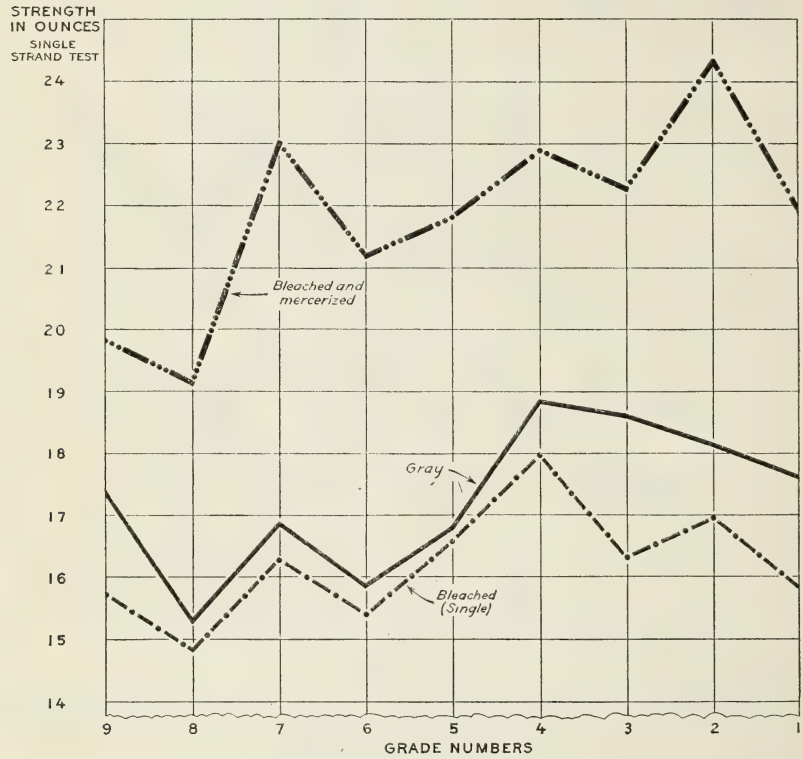

FIG. 9.—Strength in ounces per single strand as determined by 32 observations of each grade of 28s two-ply yarn spun from eastern upland cotton. (21.1 turns per inch in yarn.) The mercerized yarns were stronger than the gray and the gray yarns were stronger than the bleached

The percentage of breaks below a specified magnitude or standard may be read from these curves. As an illustration, take Figure 12 and read on horizontal 100-pound line to the intersection of No. 1 curve and down on a vertical line through this point, which shows that 21 per cent of this grade broke below the given magnitude, 100 pounds. Similarly, other percentages of breaks may be read. In judging the relative values of yarns it is important to know the percentage of these low breaks as well as their distribution.

The average deviation is determined by averaging the differences between each item and the average (disregarding plus and minus

signs), dividing this result by the average break and then multiplying by 100 (method 2). The percentage of extreme variation is determined by subtracting the minimum from the maximum and dividing by the average break and then multiplying by 100 (method 2). Similarly, the irregularity of the size or number of the yarn may be determined. (See Tables 6 and 7 for data.) Method 1 has some advantage over method 2, for the reason that the results may be more readily grasped from a graph than from a table of figures.

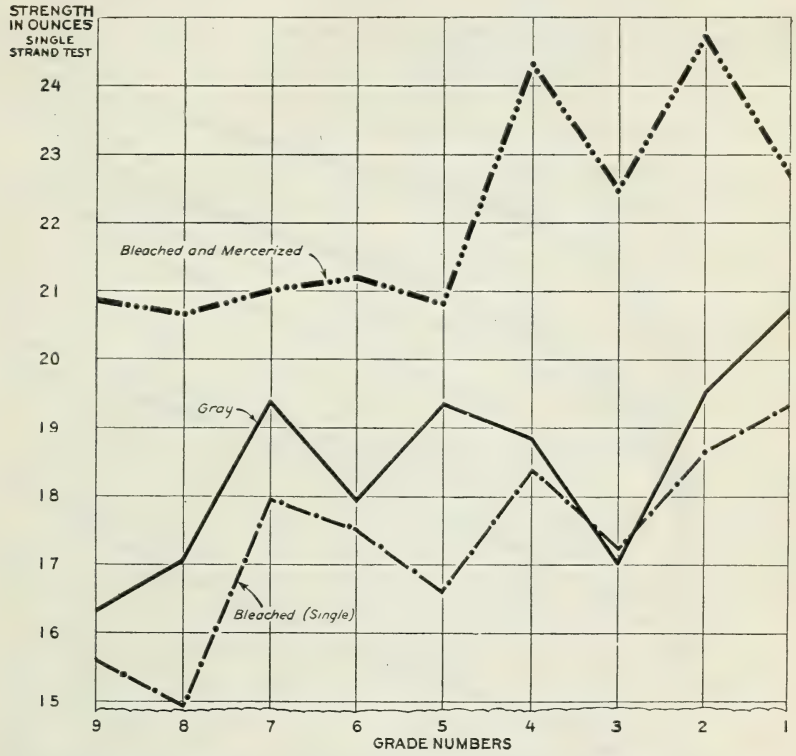

FIG. 10.—Strength in ounces per single strand as determined by 32 observations of each grade of 28s two-ply yarn spun from western upland cotton. (21.1 turns per inch in yarn.) The mercerized yarns were stronger than the gray and the gray yarns were stronger than the bleached except on grade No. 3

The results of these calculations indicate that there is no definite relation between the grade and the uniformity of the 22s yarn. Averaging the nine grades together (method 2) gave the results shown in Tables 9 and 10. These figures indicate that this particular double bleach caused the yarn to become more irregular.

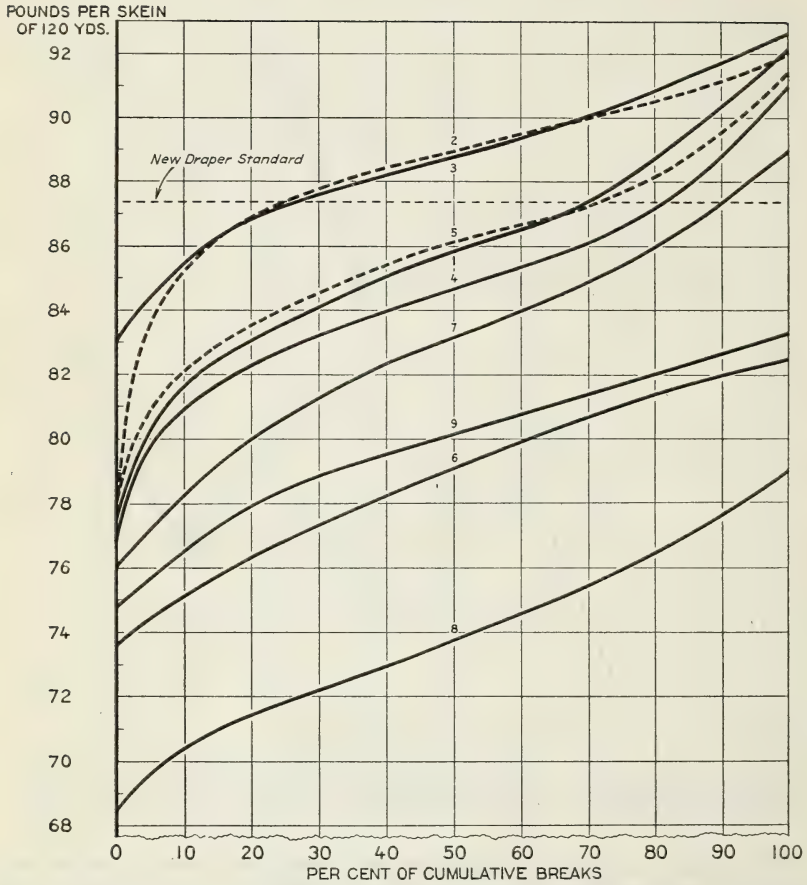

FIG. 11.—Range of strength of 22s warp yarn spun from eastern upland cotton. The range of strength of the yarn is represented by a curve according to grade. The greater the angle the curve makes with the horizontal, the more irregular the yarn

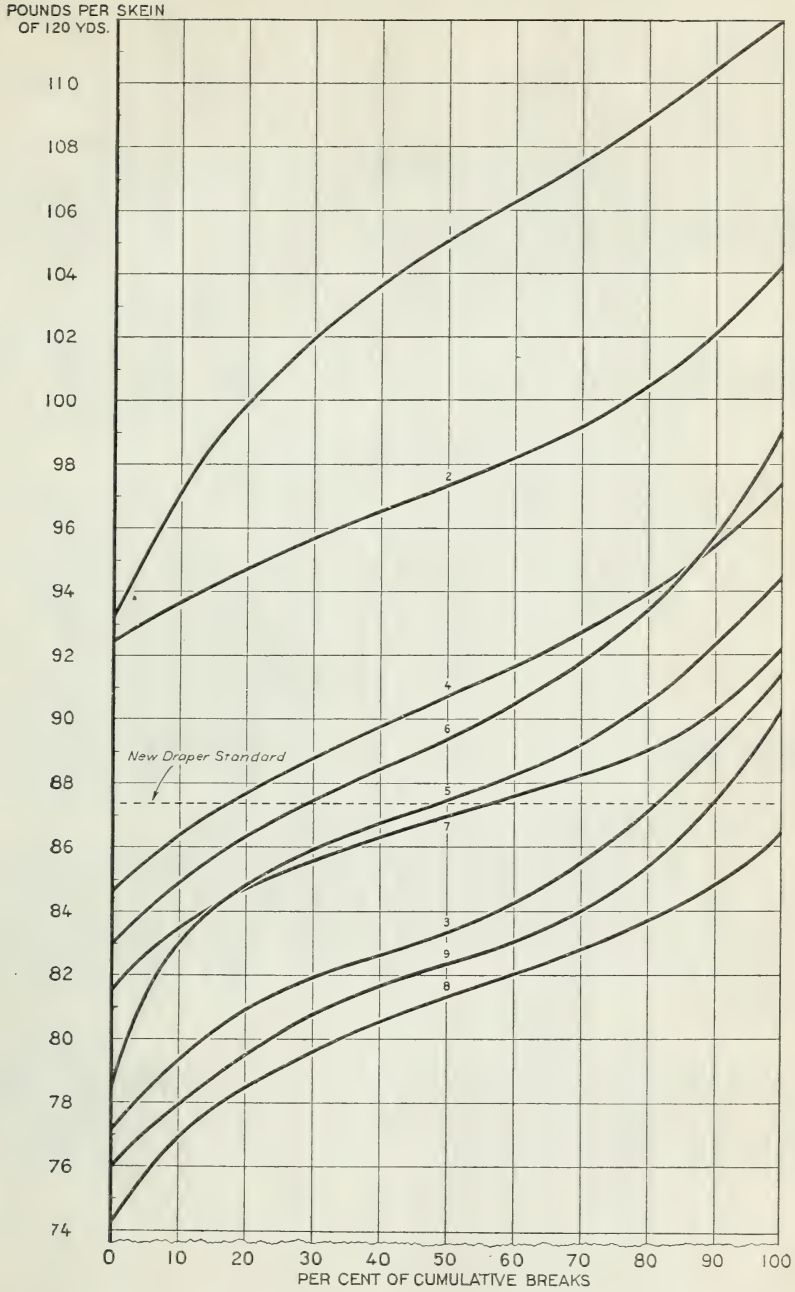

FIG. 12.—Range of strength of 22s warp yarn spun from western upland cotton. The range of strength of the yarn is represented by a curve numbered according to grade. The greater the angle the curve makes with the horizontal, the more irregular the yarn

TABLE 9.—*Average irregularity of the nine grades of eastern and western yarns* [1]

Kind of yarn	Average deviation			
	Eastern		Western	
	Strength	Size	Strength	Size
	Per cent	*Per cent*	*Per cent*	*Per cent*
Gray	3.61	1.85	3.94	2.13
Bleached (single)	3.79	2.06	3.65	1.76
Bleached (double)	4.60	2.46	4.49	2.55
Dyed	3.39	1.97	3.50	1.88
	Average extreme variation			
Gray	18.20	9.99	20.56	10.40
Bleached (single)	18.43	10.60	18.16	8.64
Bleached (double)	20.58	11.73	22.17	11.43
Dyed	16.55	10.29	17.22	9.57

[1] Obtained by 24 observations made on 22s yarn with 21.1 turns per inch (skein test).

TABLE 10.—*Average irregularity of the strength of the nine grades of eastern and western 22s yarns* [1]

Kind of yarn	Average deviation of strength		Average extreme variation of strength	
	Eastern	Western	Eastern	Western
	Per cent	*Per cent*	*Per cent*	*Per cent*
Gray	8.65	8.63	44.72	40.85
Bleached (single)	8.38	7.72	46.39	42.70
Bleached (double)	10.51	10.40	52.73	55.54
Dyed	8.96	9.49	45.88	48.10

[1] Obtained by the single-strand method from 32 observations of each grade.

The results shown in Tables 9 and 10 were obtained from the same yarn, the only difference being in the method of testing. Table 9 gives the results of the skein tests, whereas Table 10 gives the results of the single strand tests. The latter method checked the skein tests in respect to the relative uniformity of the single bleach and double bleach.

28s TWO-PLY YARN (SINGLE STRAND)

The irregularity of the strength of the 28s two-ply yarn (single-strand test) finished by different mills is given in Table 11. Note that the percentages are less than those on the single yarns. (See Table 10.) This conforms to the general belief that ply yarns are more uniform than single yarns.

TABLE 11.—*Irregularity of strength of 28s two-ply yarn (single-strand test)*

Mill and kind of yarn	Average deviation of strength		Average extreme variation of strength	
	Eastern	Western	Eastern	Western
MILL S	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Gray	6.25	7.34	32.42	43.29
Bleached (single)	6.01	6.14	33.50	35.68
Bleached (double) [1]	6.81	5.37	35.70	27.93
Mercerized	7.48	7.81	39.51	39.53
Dyed	7.10	7.45	35.53	39.32
MILL H				
Gray	6.25	7.34	32.42	43.29
Bleached (single)	6.90	6.81	34.47	37.85
Bleached (double) [1]	6.24	8.20	33.84	41.14
Mercerized	6.67	7.03	37.95	38.34
Dyed	7.18	7.01	39.21	35.38

[1] Average of grades Nos. 7, 8, and 9 only.

VARIATION OF THE SIZINGS[3]

The question has frequently arisen as to what variation in the size or weighings of the stock at different manufacturing processes may be expected. During this test weighings were made as follows:

Breaker picker lap, 2-yard lengths, weighings from each lap.
Finisher picker lap, 2-yard lengths, weighings from each lap.
Card sliver, 1-yard lengths, 24 weighings.
Drawing sliver, 1-yard lengths, 24 weighings.
Roving, 12-yard lengths, 24 weighings.
Spinning, 120-yard lengths, 24 weighings.

From these weighings the percentages of average deviation and extreme variation were determined. Table 12 gives the average of the nine grades.

TABLE 12.—*Percentages of average deviation and extreme variation in the sizings of stock at the different manufacturing processes*

Stock	Average deviation		Average extreme variation	
	Eastern	Western	Eastern	Western
	Per cent	*Per cent*	*Per cent*	*Per cent*
Breaker picker lap	3.94	4.07	12.56	13.74
Finisher picker lap	1.28	1.17	3.92	3.62
Card sliver	4.94	6.10	20.88	24.69
First drawing sliver	2.33	2.10	10.08	9.62
Second drawing sliver	.95	.95	5.21	4.73
Slubber roving	1.32	1.05	5.48	5.19
Intermediate roving	1.37	1.27	6.16	5.73
Fine frames roving	2.40	2.27	12.25	10.30
Yarn (19.9 turns)	1.85	2.13	9.99	10.40

[3] Sizing, or size, (trade names) as used throughout this bulletin refers to the hank or the number of the yarn.

DIFFERENCE IN VALUE BETWEEN GRADES

In judging the advantages of one grade of cotton over another grade several factors should be considered: Cost of the raw stock, storage and handling charges, quantity of waste discarded, value of waste, number of machine hours required to handle the cotton, and selling price of yarn.

To illustrate the relative importance of these factors, the writer has derived a formula based on estimated average conditions. The following discussion of these factors may aid in the interpretation of the formula.

The differential in price of raw stock, both of the low grades and of the high grades on the basis of Middling cotton, fluctuates with supply and demand. However, the five-year average prices in cents per pound for grades 1 to 9, respectively, based on the average of the 10 designated spot cotton markets as of the first day of each month, September 1, 1920, to August 31, 1925, inclusive, are as follows: 24.83; 24.46; 24.06; 23.60; 23.02; 22.05; 20.73;19.59; 18.47.

Except in special cases the total storage and handling charges are greater for low-grade cotton than for high-grade cotton when the same given quantity of finished yarn is desired.

The lower the grade, the higher the waste percentage. Table No. 4 shows the waste percentage to range from 5.50 on grade No. 1 to 14.44 on grade No. 9. The value of this waste depends upon supply and demand. The estimated prices or relative values at the time of these tests, however, were found to range from one-fourth cent per pound for picker motes from grade No. 9 to 17 cents per pound for card strips from grade No. 1. At this time grade No.1 cotton was quoted around 25 cents per pound. (See Figure 13 for approximate relative values of waste and average prices of cotton as above given.)

The cost for picking and carding in this formula is figured on the machine-hour basis rather than on pounds delivered. The cost of operating the card per hour on low-grade cotton is as much as, and in some cases more than, the machine-hour cost for high-grade cotton. This cost per hour prevails whether the card is producing or being ground. More frequent grinding of the card is required when low grades are being run. As an example, most cards need grinding after 1,200 to 1,500 pounds of low-grade cotton have been fed, whereas 1,600 to 2,200 pounds of high-grade cotton may be run before grinding is required. Therefore the number of hours lost in grinding is greater when low grades are carded.

The price of yarn fluctuates as well as the differential in price between yarns from different grades of cotton. Therefore this price factor can be determined only at the time when the problem arises, using the prices as of that period.

The gross weight of cotton required to produce a given quantity of yarn from any grade of cotton may be determined by dividing the pounds of finished yarn by 1 minus the percentage of total waste expressed decimally.

This formula is not to be interpreted as a system of cost accounting, but values obtained by the usual cost systems may be substituted in the formula for the purpose of obtaining the practical difference between the grades under consideration.

There are certain factors which can not be included in any formula for determining the value of grade. For example, a mill may have built up a trade on converters' goods, in which bleaching and finishing qualities are chief requisites. In such cases the use of low grades may be inadvisable, even though the prices are materially lower than those for high grades. But if the product is for other uses where

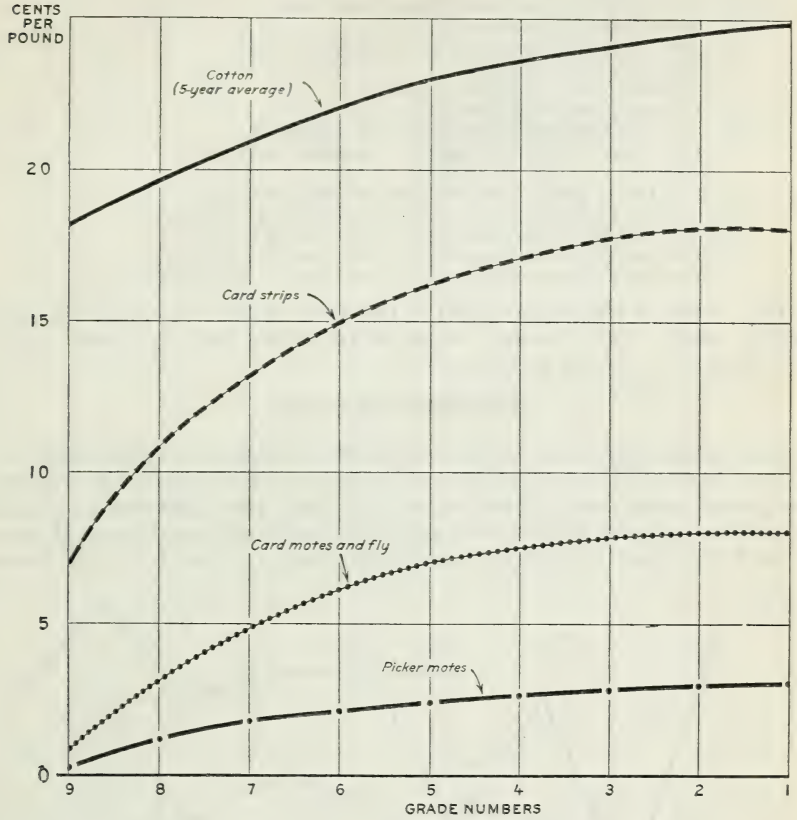

FIG. 13.—Average price of cotton by grade and estimated prices of waste from cotton of the several grades. Relative values of grades are based on five-year averages as of the first day of each month, September, 1920, to August, 1925. The relative values of waste are based on estimates as of August, 1925, obtained by personal interviews with waste dealers and cotton manufacturers

bleaching is not a chief requisite, the low grades might be used more advantageously in case the spread in prices between grades was great.

The formula will show the immediate monetary difference between the grades, but the choice of the grade must rest upon the discretion of the management of the mill.[4]

[4] Valuable suggestions regarding this formula have been received from R. E. Loper, specialist in textile cost service and William Smith, principal, New Bedford Textile School.

If M = Market price of yarn of grade under consideration
Then $(M_3 - Y_3) - (M_9 - Y_9)$ = Advantage of grade 3 over grade 9.
The value of Y may be determined as follows:

$$Y = \frac{(CS \times G) + (P \times G) + \left(\frac{G-T}{Fp}\right) CMp + (1-Wp)\left[\left(\frac{G-T}{Fc}\right) + \left(\frac{G-T}{N}\right) H\right] CMc - Vw}{(G-T)\ (1-Wp)\ (1-Wc)\ (1-Ws)} + S$$

Where Y = cost of yarn per pound,
CS = cost per pound for storing and handling,
G = gross weight of cotton,
P = price of cotton (grade under consideration),
T = tare (bagging and ties),
F = amount fed to machine per hour,
p = pickers (used as subnotation),
CM = cost per machine hour (labor and overhead),
W = percentage of waste removed expressed decimally,
c = cards (used as subnotation),
N = number of pounds fed between grindings of card,
H = number of hours required for each grinding of card,
Vw = value of waste and tare from G pounds of cotton,
S = cost per pound subsequent to cards through spinning,
s = processes subsequent to cards (subnotation for front waste).

The value of the waste (Vw) is the sum of the values of the component parts—tare, picker motes, card motes and fly, card strips, and front or reusable waste.

STRENGTH OF CLOTH

Each grade of cotton was spun into 28s filling yarn and woven into a five-harness filling-effect sateen, using a high grade 40s two-ply untreated warp yarn. Portions of this cloth were bleached; portions were bleached and mercerized; and other portions were bleached, mercerized and dyed by different finishing plants. The cloth was tested

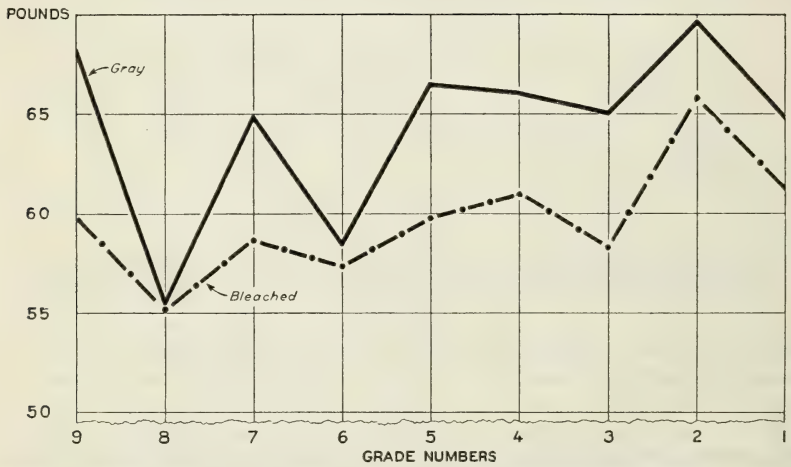

FIG. 14.—Effect of bleaching on the strength of the eastern cloth. Bleaching tends to weaken the cloth

fillingwise, using a 1-inch strip with the jaws of the machine set 3 inches apart. Five observations were made of each finish—gray, bleached, dyed, and mercerized. The resultant average of the five observations of each treatment is denoted by the intersection of the slope line with the vertical line representing the grade of cotton (figs. 14, 15, 16, and 17.)

The cloth was finished in two different mills. The results of the average strength tests of the cloth are shown graphically by Figures 14, 15, 16, and 17.

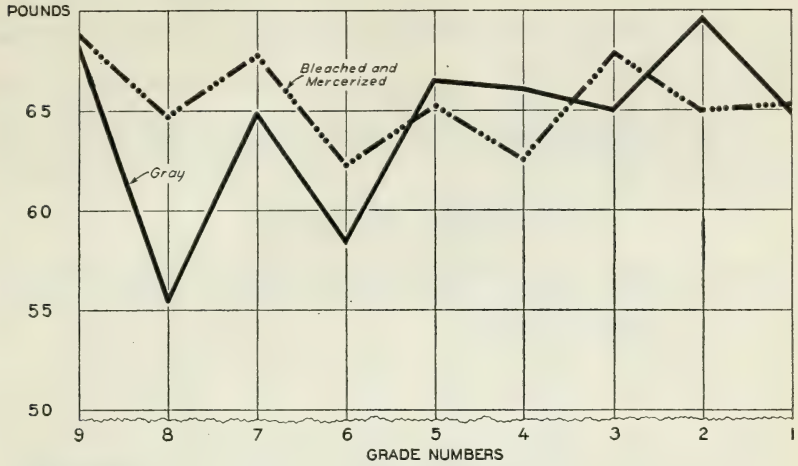

FIG. 15.—Effect of mercerizing on the strength of the eastern cloth. Mercerizing tends to strengthen the cloth

The main fact brought out by the cloth tests was the effect of the different finishings on the strength of the cloth. Bleaching reduced the strength of the cloth approximately 7 per cent, mercerizing increased the strength approximately 1.5 per cent, and dyeing on a bleached base reduced the strength approximately 5.5 per cent.

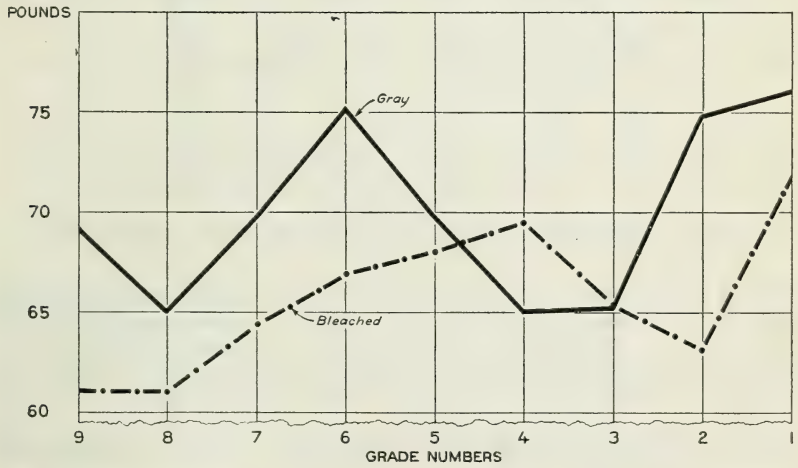

FIG. 16.—Effect of bleaching on the strength of the western cloth. Bleaching tends to weaken the cloth

MANUFACTURING PROPERTIES

A considerable quantity of dust and fly was given off while the the lower grades (Nos. 7, 8, and 9) were being machined. Considerable pin trash continued to adhere to the fibers after they had

been passed through the pickers and cards. Some of this trash dropped from the fibers as the cotton passed through the rolls of the fly frames and spinning frames, but small particles of trash were noticeable in the gray yarn of the lower grades. These factors should be given consideration when the use of low grades is contemplated.

A record of the broken ends occurring while the yarns were being spun was kept. This record indicated but a small difference in the end breakage except in the case of western grade No. 3. Excess difference there may be due to the general drop in strength of this grade (fig. 3).

FINISHING PROPERTIES

In the bleached and dyed yarns there was a noticeable difference in the brightness of the grades. This difference was less noticeable in the mercerized yarns.

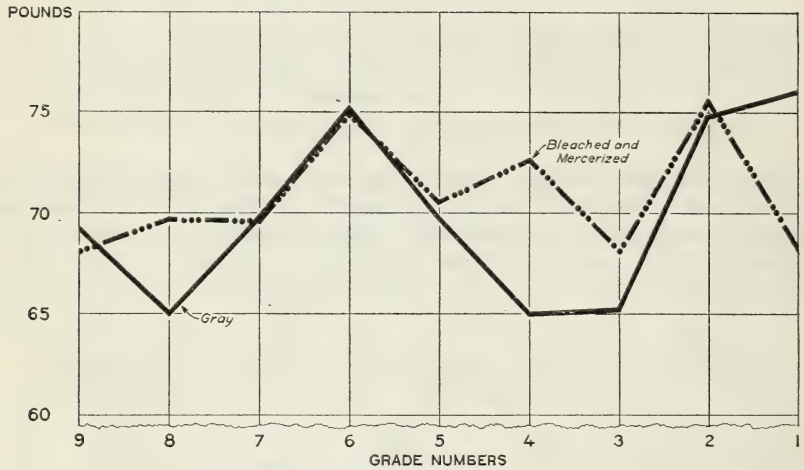

FIG. 17.—Effect of mercerizing on the strength of the western cloth. Mercerizing tends to strengthen the cloth

Filling spun from each grade of cotton was used in a five-harness filling-effect sateen with a constant warp of good quality of 40s two-ply yarn. Portions of this cloth were bleached; portions were bleached and mercerized; and portions were bleached, mercerized, and dyed. Results of the strength tests on this cloth have been described (figs. 14, 15, 16, and 17). Results of the tests of the bleached and mercerized cloth for brightness are shown graphically in Figure 18.[5]

In the case of the bleached cloth of this test it was found that in most instances an increase of brightness was accompanied by a decrease in strength or vice versa.

The brightness of the gray cloth woven from grades 6, 7, 8, and 9 was increased by the removal of the foreign matter from these grades. The increase in brightness of the bleached cloth over the mercerized

[5] Method recommended by E. E. Chandler, formerly of the Bureau of Agricultural Economics, consisting of placing the cloth on blocks of wood in a dodecahedron and measuring the reflection of light by the use of a photometer.

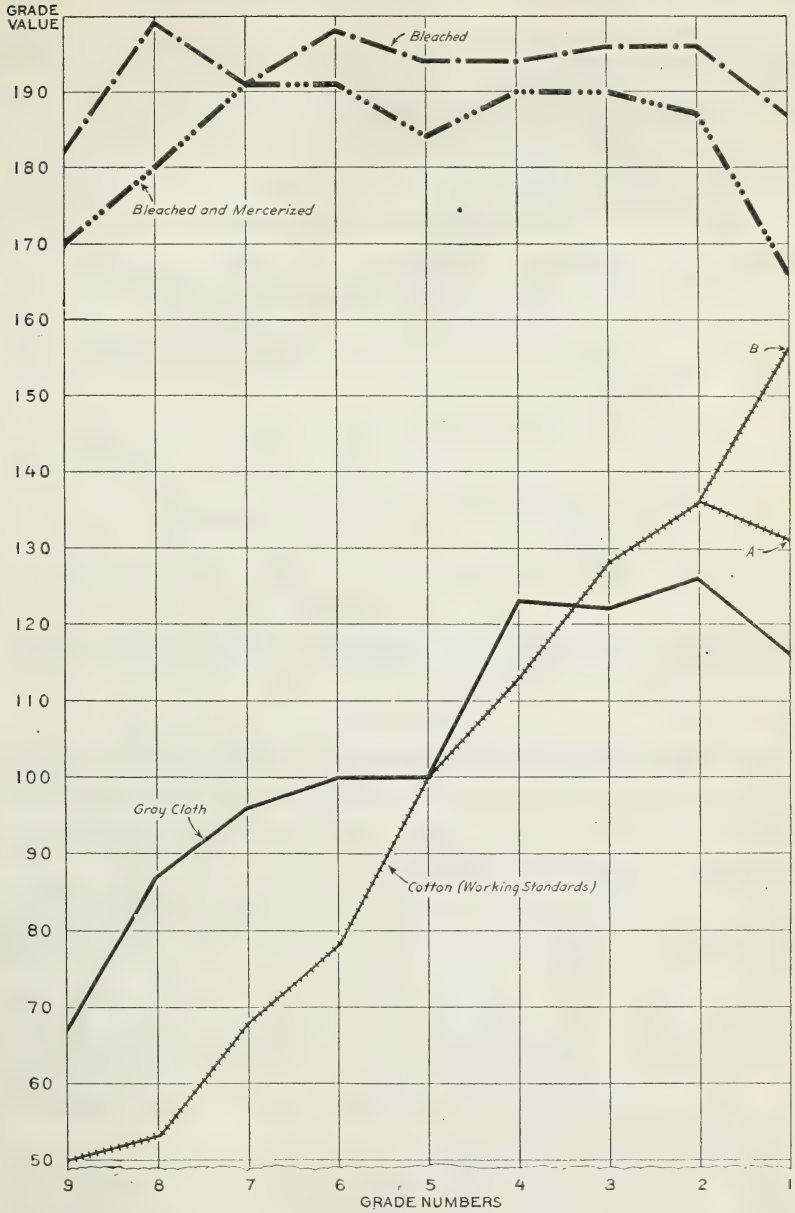

FIG. 18.—Comparative brightness of cotton and cloth as determined by photometric readings. The brightness of the gray cloth of grades 6, 7, 8, and 9 is considerably improved over the brightness of the corresponding grades of cotton. The bleached cloth is brighter than the mercerized. Grade No. 5, valued as 100, is the base for all photometric readings. Grade No. 1 (A) is taken from a box of the working standards, whereas grade No. 1 (B) is from a special sample of grade No. 1

cloth is probably due to the fact that fibers are transparent after mercerization, hence some of the light is absorbed instead of being reflected (fig. 18).

The strength of the gray cloth fillingwise tends to follow the strength of the gray yarns. The strength of the latter is greater because more twist was inserted in the warp yarn and more threads were tested in each instance (fig. 19).

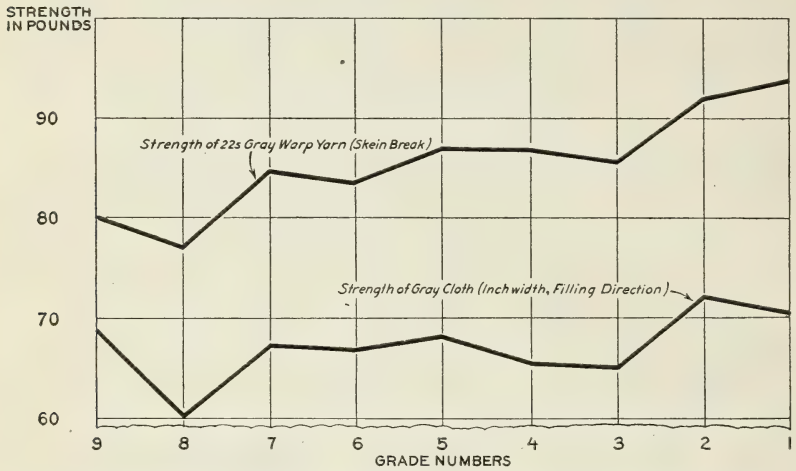

FIG. 19.—Strength of gray cloth compared with gray warp yarns spun from the same grades. (Average of eastern and western.) The strength of the gray cloth fillingwise tends to follow the strength of the gray warp yarn from the same grade

SUMMARY

These spinning tests were conducted to determine the relative intrinsic value of each of the nine white grades of American upland cotton.

For comparative purposes all grades were run under similar mechanical and moisture conditions.

The average percentages of visible waste from the nine grades of cotton representing the universal cotton standards, when run under these conditions ranged from 5.50 per cent on grade No. 1 to 14.44 per cent on grade No. 9. (See Table 4.)

The strength of the yarn did not always follow the grade of the cotton, but there was a tendency for the higher grades to produce stronger yarns. Bleached yarns of all the grades were weaker than the corresponding gray yarns, whereas the mercerized yarns were stronger. The strength of these finished yarns followed closely the strength of the gray yarns.

The irregularity of the sizings of the stock in process and of the strength and sizings of the yarns was independent of the grade of the cotton. Double-bleached yarns were more irregular than single-bleached. No marked difference was noted in the regularity of gray, single-bleached, and dyed yarns.

A formula has been suggested for estimating the difference in the relative values of the grades.

The different grades of cotton were spun into 22s warp yarn satisfactorily. A considerable quantity of dust and fly was given off when running grades 7, 8, and 9.

The finishing properties of the lower grades for bleaching and dyeing were not so satisfactory as those of the higher grades. The lower grades produced less bright yarns than did the higher grades. Brightness of the lower grades may be obtained by bleaching, but this is usually done at a sacrifice of strength.

The strength of the finished 22s warp yarns and the 28s two-ply soft twisted yarns followed generally the strength of the gray yarns. The effect of the finishing was practically the same for eastern and western yarns.

The strength of the gray cloth followed closely the strength of the gray yarns.

The strength and regularity of the finished yarns and cloth varied with the finishing plants and the methods used.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

March 24, 1927

Secretary of Agriculture	W. M. JARDINE.
Assistant Secretary	R. W. DUNLAP.
Director of Scientific Work	A. F. WOODS.
Director of Regulatory Work	WALTER G. CAMPBELL.
Director of Extension Work	C. W. WARBURTON.
Director of Information	NELSON ANTRIM CRAWFORD.
Director of Personnel and Business Administration	W. W. STOCKBERGER.
Solicitor	R. W. WILLIAMS.
Weather Bureau	CHARLES F. MARVIN, *Chief.*
Bureau of Agricultural Economics	LLOYD S. TENNY, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Forest Service	W. B. GREELEY, *Chief.*
Bureau of Chemistry	C. A. BROWNE, *Chief.*
Bureau of Soils	MILTON WHITNEY, *Chief.*
Bureau of Entomology	L. O. HOWARD, *Chief.*
Bureau of Biological Survey	E. W. NELSON, *Chief.*
Bureau of Public Roads	THOMAS H. MACDONALD, *Chief.*
Bureau of Home Economics	LOUISE STANLEY, *Chief.*
Bureau of Dairy Industry	C. W. LARSON, *Chief.*
Office of Experiment Stations	E. W. ALLEN, *Chief.*
Office of Cooperative Extension Work	C. B. SMITH, *Chief.*
Library	CLARIBEL R. BARNETT, *Librarian.*
Federal Horticultural Board	C. L. MARLATT, *Chairman.*
Insecticide and Fungicide Board	J. K. HAYWOOD, *Chairman.*
Packers and Stockyards Administration	JOHN T. CAINE III, *in Charge.*
Grain Futures Administration	J. W. T. DUVEL, *in Charge.*

This bulletin is a contribution from

Bureau of Agricultural Economics	LLOYD S. TENNY, *Chief.*
Division of Cotton Marketing	ARTHUR W. PALMER, *Chief Marketing Specialist, in Charge.*

ADDITIONAL COPIES
OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT
10 CENTS PER COPY